

Diet and kidney rehabilitation in dialysis patients

Diet in dialysis patients

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Abstract

There are not enough studies on the benefits and harms of traditional and uniform dietary restriction in dialysis patients. For example, many studies show that restriction of phosphorus in the diet of dialysis patients may lead to a worse nutritional status and will have a worse process. In addition, the restriction of potassium in the diet may deprive dialysis patients of healthy diets related to the heart. This may lead to the intake of more atherogenic diets. Another important point is that there is little data on the benefits of dietary sodium restriction for dialysis patients. Also, limiting fluid intake in dialysis patients who need protein may naturally lead to lower protein and calorie consumption. In diabetic dialysis patients, who are also wrong about carbohydrate intake, this situation may cause harm instead of benefit. Since dietary fat containing omega-3 fatty acids can be important sources of calories for dialysis patients, it is not very correct to restrict it. Also, data to justify other dietary restrictions on calcium, vitamins, and trace elements in dialysis patients are scarce, and this is often contradictory.

Recently, the concept of renal rehabilitation, which includes exercise and nutrition programs for patients with chronic kidney disease, has become popular. Renal rehabilitation, which includes both nutrition and physical activity, has beneficial effects on the patient's physical ability and quality of life in dialysis patients. In this review, information about what should be done in the diets applied in dialysis patients, the mistakes made and renal rehabilitation are given.

Keywords

Dietary Restriction, Protein Intake, Dietary Load, Nutritional Management, Renal Rehabilitation

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Introduction

Dietary management of patients with chronic kidney disease (CKD), including those receiving dialysis treatment, is very important. Therefore, all dialysis patients should definitely seek counseling from a dietitian and nephrologist for diet regulation and counseling [1]. Both dietitians and nephrologists often place dialysis patients on a set of dietary restrictions regarding phosphorus, potassium, sodium, fluid intake, and carbohydrates and fat. In addition, while many dietitians recommend high dietary protein intake to their patients, some dietitians recommend losing weight to their patients [2]. There are also many different recommendations regarding food during hemodialysis treatment around the world. In some countries, food intake is recommended during dialysis, while in others it is prohibited [3].

In general, the diet programs recommended for dialysis patients worldwide are quite restrictive. Finding and applying the foods that are allowed to eat in dialysis patients involve great difficulties for patients. Dialysis diet, which is among the most restrictive diets, is difficult for many patients and this situation causes compliance problems in patients. In this review, some dietary recommendations and restrictions for dialysis patients are reviewed and information about renal rehabilitation is given.

Dietary protein recommendations for dialysis patients

The minimum dietary protein requirement should be above 0.2 g/kg/day against protein-energy malnutrition. Protein intake in the general non-vegetarian population in the US and most Western countries is 0.9-1.1 g/kg/day. In the healthy general population, daily dietary protein intake should be 0.8 g/kg/day. Low amounts of protein are generally recommended for patients with chronic kidney disease (CKD) who are not dependent on dialysis. Generally, the recommended low protein diet for non-diabetic dialysis patients is calculated to have a daily protein intake of 0.6 g/kg/day (35-45 g protein for a 60 to 70 kg person). A very low protein diet consists of only 0.3 g/kg/day, and this ratio is recommended for patients with CKD in the very late stage [4-6]. This recommended amount is higher than that of the general healthy population and those on a low protein diet [7]. However, a high daily protein intake of 1.2 g/kg/day brings a somewhat high dietary phosphorus and potassium load. This poses additional challenges due to the higher risk of metabolic acidosis and the possibility of higher fluid intake due to the greater food volume requirement. For this reason, controlled and balanced protein intake should be made according to the patient.

By calculating the advantages of higher dietary protein intake, recommendations can be made for patients undergoing hemodialysis three times a week to eat more fruits and vegetables with high protein content, such as meat, fish, eggs, poultry, legumes, and tofu-based foods [3, 5].

Phosphorus restrictions in dialysis patients

Phosphorus monitoring in dialysis patients is one of the most time-consuming tasks for dietitians. According to recent studies in dialysis patients, it has been revealed that restriction of phosphorus will result in lower protein intake and this may increase the risk of death due to protein-energy loss [8].

A study by Lynch et al found that prescribed dietary phosphorus restrictions were associated with poorer indicators of nutritional status, and patients with less phosphorus restriction had a higher survival rate. According to this study, the survival rate of patients with and without dietary restriction in terms of phosphorus was 27% and 29%, respectively [9].

In another study by Shinaberger et al., the survival rate was 10% higher in patients with decreased serum phosphorus but increased protein intake, while the survival rate was 11% in patients with increased

phosphorus but decreased dietary protein. In the same study, it was determined that the survival rate of those whose phosphorus and dietary protein intakes decreased at the same time was 6% [8]. Accordingly, both old and new data show that a low serum phosphorus level (<3.5 mg/dL) is associated with higher mortality regardless of age [10]. According to these studies, direct restriction of phosphorus and protein in dialysis patients may bring more harm than benefit. Therefore, restriction of phosphorus and protein intake in the diet of dialysis patients should be done by considering the benefit of the patient.

Potassium restrictions in dialysis patients

Dietary potassium restrictions are practiced in the early stages of nondialysis-dependent CKD and in most patients on hemodialysis who progress to end-stage renal disease. In a cohort study of hemodialysis patients, patients with a pre-hemodialysis serum potassium range of 4.6 to 5.3 mEq/L had a higher survival rate, whereas patients with potassium levels <4.0 or ≥5.6 mEq/L had a higher mortality rate. In the same study, it was determined that patients who consume more protein also tend to have higher serum potassium levels [11]. In a different cohort study, it was suggested that the risk of death increased even more when serum potassium levels were <3.5 mEq/L and ≥5.5 mEq/L in dialysis patients [12]. These studies show that direct potassium restriction in dialysis patients is not correct, and very low and high serum potassium levels are bad for the patient. Therefore, both hypokalemia and hyperkalemia appear to be harmful in patients regardless of the dialysis method. The variability of serum potassium in dialysis patients is not directly related to dietary potassium intake, but some other factors, such as potassium concentration in the dialysate bath, length and frequency of dialysis treatment, are important factors affecting potassium levels. Therefore, choosing beneficial potassium sources with a more balanced and realistic approach rather than dietary potassium restriction according to the patient's condition will benefit the patient [7].

Carbohydrate load and dietary glycemic restrictions in dialysis patients

A large proportion of patients on dialysis also struggle with diabetes. For example, almost half of dialysis patients in the United States are diabetic. Another important situation is that most diabetic dialysis patients are subject to the same dietary restrictions as patients with diabetes [13]. Although a high glycemic load in dialysis patients is associated with many poor outcomes, many diabetic dialysis patients are at risk of hypoglycemia from time to time. Therefore, insulin and oral hypoglycemic agents are reduced in these patients [14].

Indeed, hypoglycemia caused by hemodialysis is an underrecognized and common condition that may occur more frequently in diabetic dialysis patients [15]. Recent studies show that the best HbA1c target range for diabetic dialysis patients is 7 to 9%, with an HbA1c value of <6% is associated with malnutrition or uremia [14]. Therefore, glycemic restrictions applied in diabetic patients without CKD may cause more harm than benefit in diabetic dialysis patients. Therefore, dialysis patients with HbA1c <7% should not have strict dietary glycemic restrictions, and in patients with higher HbA1c levels, a careful and balanced diet of 35 Cal/kg/day should be considered [5].

Dietary salt and fluid restriction

Although there is substantial data showing that high weight gain is associated with a higher risk of death between dialysis patients, there are no convincing data to suggest that sodium restriction has any effect on outcomes in dialysis patients. Indeed, according to recent studies, it is stated that low salt intake in dialysis patients leads to worse outcomes [16].

In a study on fluid restriction, high fluid, weight, and protein intake in

hemodialysis patients were associated with greater survival at first, while the same factors were associated with a higher risk of death in later cases. Accordingly, attention should be paid to adequate fluid intake focusing on optimal nutritional status rather than fluid restriction in dialysis patients [17].

It is also wrong to completely eliminate fluid and salt restrictions in dialysis patients because of the difficulties associated with high volume overload. However, especially in dialysis patients with significant residual kidney function and urine output, salt and fluid restrictions should not be high.

Fat restrictions in dialysis patients

Although there are recommendations for low dietary fat in the general population, there are no convincing data showing any advantage of fat restriction in dialysis patients. Although the prevalence of hypertriglyceridemia in the general population and dialysis patients is close to each other, hypercholesterolemia is less common in dialysis patients [18]. In most epidemiological studies, it has been reported that higher lipoprotein and body fat are associated with longer survival in dialysis patients, while the relationship with HDL is more complex [19]. For this reason, reaching optimal fat and lipoprotein levels with dietary modulations in dialysis patients can contribute positively to patients.

In other studies, the anti-inflammatory benefits of excessive dietary intake of certain fats such as omega-6/omega-3 have been suggested [20]. Therefore, although it has not been proven yet, dietary fat is both a good source of necessary calories and, if applied properly, contributes to the reduction of inflammation [21].

Vitamin and trace element deficiency in dialysis patients

In dialysis patients suffering from protein-energy aspects, micronutrient deficiencies such as trace elements and vitamins are also observed. Common vitamin deficiencies observed in dialysis patients include vitamin C (ascorbic acid), vitamin B6, folate, and calcitriol. In addition, trace element deficiencies such as iron, zinc and selenium can be observed in the same patient group. On the other hand, the majority of toxicities in dialysis patients can be caused by aluminum and copper [22]. Deficiency of these essential substances in dialysis patients is often associated with inadequate intake of natural resources such as fresh fruit and vegetables due to dietary restriction. In order to eliminate such deficiencies, the diet of dialysis patients should include adequate amounts of fresh fruits and vegetables containing antioxidant vitamins such as vitamins E, C, and carotenoids [22].

Calcium restrictions in dialysis patients

With the advent of calcium-free phosphorus binders and recent data on vascular calcification, changes have been made recently to current paradigms regarding maintaining a positive calcium balance and recommending low dietary calcium [23].

Although the majority of epidemiological studies show serum calcium levels >10.5 mg/dL as a high risk of death, serum calcium levels less than <8.5 mg/dL are also associated with higher mortality [24]. More calcium intake is not the only reason for high calcium levels in the blood, but this may also be caused by other hormonal disorders, including hyperparathyroidism [25]. In this respect, instead of restricting the calcium diet of dialysis patients directly, it is necessary to decide on this after conducting the necessary examinations and evaluations of patients.

Eating and drinking restrictions during hemodialysis

There are significant restrictions on eating and drinking during hemodialysis treatment in dialysis clinics in the United States and Canada. Reasons for these restrictions include postprandial hypotension, aspiration risk, infection control and hygiene, diabetes and phosphorus control, need for dialysis personnel, and cost. However, in other countries such as Germany and Japan, patients are provided

with food and beverage services during each hemodialysis treatment session [3]. In fact, providing high-protein meals and/or oral nutritional supplements during the treatment of patients carefully selected and followed up during hemodialysis is a viable patient-friendly strategy. Eating and drinking and supplements during hemodialysis are not very costly and are economically feasible [3].

Renal rehabilitation in dialysis patients

With the increasing number of dialysis patients, the concept of renal rehabilitation, which includes exercise and nutrition programs for patients with chronic kidney disease, has become popular recently. Renal rehabilitation for CKD patients is a comprehensive multidisciplinary program led by doctors, rehabilitation therapists, nutritionists, nurses, social workers, pharmacists and therapists [26]. According to many observational studies, better results in terms of kidney were seen in CKD patients with high physical activity. In addition, according to recent systematic reviews, the exercise program carried out in dialysis patients has shown beneficial effects on the patient's physical ability and quality of life. However, the beneficial effect of exercise programs on overall mortality remains unclear.

Skeletal muscle loss occurs in CKD patients for many reasons. One of these reasons is insufficient and unbalanced nutrition. In order to prevent muscle loss in dialysis patients, it is especially important to take adequate and regular proteins. Therefore, nutritional support is very important in renal rehabilitation. Therefore, in addition to exercise, an adequate source of energy, including carbohydrates, proteins, iron and vitamins, is needed to prevent protein catabolism. Due to decreased digestive function and energy loss due to dialysis treatment, dialysis patients are recommended to take 1.2 times more protein than the normal population. Motivating patients to participate in activities is also an important part of renal rehabilitation. It is important for everyone to understand the importance of renal rehabilitation to maximize patient satisfaction [27].

The renal rehabilitation guide

Although a series of articles and narrative reviews about exercise in CKD were first published in 2010, there were no comprehensive guidelines on exercise and physical activity for CKD patients at that time. The first guideline was published in 2012 to increase physical activity levels in kidney patients. Later, in 2013 and 2014, guidelines on aerobic, resistance and flexibility exercises were published in CKD patients in Australia and the USA [28, 29]. However, at this point, there were no specific recommendations regarding the types, intensity, and volume of certain types of exercise for CKD patients. Thanks to these advances, clinical practice guidelines for renal rehabilitation were established by the Japanese Society of Renal Rehabilitation in 2018 [30]. This guideline constitutes an important example of the first clinical practice guidelines for renal rehabilitation based on systematic reviews and evidence.

Physical activity in dialysis patients

Physical activity levels are greatly reduced in dialysis patients compared to the general elderly population. The reasons for this include inactivity for the dialysis procedure and the tendency of patients to have a sedentary lifestyle on the day of dialysis due to post-dialysis fatigue syndrome. It has been reported that physical activity in dialysis patients is 17% lower on dialysis days compared to non-dialysis days [31].

Dialysis patients often have many disorders that can lead to comorbidities such as sarcopenia, mitochondrial dysfunction, anemia, bone and mineral disorders, diabetes, neurological dysfunction, cardiovascular dysfunction, diabetes, and neurological dysfunction. These disorders are associated with reduced physical activity and are associated with loss of muscle mass [27]. These conditions cause low exercise tolerance in dialysis patients. Exercise tolerance is a strong

prognostic factor associated with mortality, independent of kidney function. Increasing or maintaining exercise tolerance is a key factor for improving quality of life in CKD patients.

The exercise has four main components: aerobic exercises, including walking and swimming, resistance training, including push-ups and sit-ups, flexibility exercises, represented by stretching, and balance training, represented by standing on one leg. In order to maximize the therapeutic effects of exercise in dialysis patients, these components need to be balanced in combination or individually modified.

Exercise is not just the contraction of skeletal muscles. Skeletal muscle contraction is needed for the circulatory and respiratory system to transfer energy to the body. In order to achieve exercise tolerance, it is important that the skeletal muscle, cardiovascular system, respiratory system and nervous system work together. Since exercise intensity is directly related to both the amount of improvement in exercise capacity and the risk of adverse events during exercise, attention should be paid to aerobic exercise intensity in renal rehabilitation. Therefore, although assessing muscle function is an important part of exercise, a comprehensive assessment of these organs is required to assess exercise tolerance.

Conclusion

It is unclear whether applying traditional dietary restrictions to dialysis patients contributes to better outcomes. Although some dietary restrictions may seem justified, excessive and extensive restrictions may lead to worse health outcomes as they impair the nutritional status and quality of life of patients. As stated above, strict dietary restrictions in hemodialysis patients lead to insufficient intake of protein, fat, sugar, carbohydrates, fiber, vitamins and important elements that the body needs. According to some studies, it has been determined that patients who do not comply with dietary restrictions live longer than patients who comply with dietary restrictions. However, the hypothesis that adhering to severe dietary restrictions may do more harm than good needs support.

Given the important knowledge gap discussed above, there is an urgent need for research with applicability in the nutritional management of dialysis patients. Future research in this area requires larger clinical trials to evaluate and recommend on a patient basis dietary restriction of protein, fat, carbohydrates, potassium, phosphorus, calcium and salt. Physical activity, which decreases to a minimum level in dialysis patients, causes irreversible damages in the long run. This process, which starts with the loss of muscle mass, causes serious problems in many organs and systems. In order to prevent these negative processes in dialysis patients, exercises that accelerate physical activity should be performed. Exercise programs, which are defined with the concept of renal rehabilitation and aim to build strong muscles in dialysis patients, also increase life expectancy. Rehabilitation therapists, dietary nutritionists, nursing professionals, social workers and pharmacists must work together to coordinate renal rehabilitation in dialysis patients. Exercises applied in dialysis patients include aerobic exercise, resistance training, flexibility exercise and balance training. In dialysis patients, these exercises should be combined in a balanced way and individually modified in order to increase the benefit to the dialysis patient. Both the right nutrition strategies and balanced exercises are among the most important factors that increase the quality of life of dialysis patients.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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Conflict of interest

The authors declare no conflicts of interest.

References

- Ikizler TA, Franch HA, Kalantar-Zadeh K, ter Wee PM, Wanner C. Time to revisit the role of renal dietitian in the dialysis unit. *J Ren Nutr.* 2014;24(1):58–60.
- Streja E, Molnar MZ, Kovesdy CP, Bunnapradist S, Jing J, Nissenson AR, et al. Associations of pretransplant weight and muscle mass with mortality in renal transplant recipients. *Clin J Am Soc Nephrol.* 2011;6(6):1463–73.
- Kalantar-Zadeh K, Ikizler TA. Let them eat during dialysis: an overlooked opportunity to improve outcomes in maintenance hemodialysis patients. *J Ren Nutr.* 2013;23(3):157–63.
- Kovesdy CP, Kopple JD, Kalantar-Zadeh K. Management of protein-energy wasting in non-dialysis-dependent chronic kidney disease: reconciling low protein intake with nutritional therapy. *Am J Clin Nutr.* 2013;97(6):1163–77.
- Kalantar-Zadeh K, Cano NJ, Budde K, Chazot C, Kovesdy CP, Mak RH, et al. Diets and enteral supplements for improving outcomes in chronic kidney disease. *Nat Rev Nephrol.* 2011;7(7):369–84.
- Shah AP, Kalantar-Zadeh K, Kopple JD. The Role of Keto Acid Supplements in the Management of Chronic Kidney Disease: A North American Perspective. *Am J Kid Dis.* 2014;65(5):659–73.
- Kalantar-Zadeh K, Brown A, Chen JLT, Kamgar M, Lau W-L, Moradi H, et al., Dietary Restrictions in Dialysis Patients: Is There Anything Left to Eat? *Semin Dial.* 2015;28(2): 159–68.
- Shinaberger CS, Greenland S, Kopple JD, Van Wyck D, Mehrotra R, Kovesdy CP, et al. Is controlling phosphorus by decreasing dietary protein intake beneficial or harmful in persons with chronic kidney disease? *Am J Clin Nutr.* 2008;88(6):1511–18.
- Lynch KE, Lynch R, Curhan GC, Brunelli SM. Prescribed dietary phosphate restriction and survival among hemodialysis patients. *Clin J Am Soc Nephrol.* 2011;6(3):620–9.
- Lertdumrongluk P, Rhee CM, Park J, Lau WL, Moradi H, Jing J, et al. Association of serum phosphorus concentration with mortality in elderly and nonelderly hemodialysis patients. *J Ren Nutr.* 2013;23(6):411–21.
- Kovesdy CP, Regidor DL, Mehrotra R, Jing J, McAllister CJ, Greenland S, et al. Serum and dialysate potassium concentrations and survival in hemodialysis patients. *Clin J Am Soc Nephrol.* 2007;2(5):999–1007.
- Torlen K, Kalantar-Zadeh K, Molnar MZ, Vashista T, Mehrotra R. Serum potassium and cause-specific mortality in a large peritoneal dialysis cohort. *Clin J Am Soc Nephrol.* 2012;7(8):1272–84.
- Rhee CM, Leung AM, Kovesdy CP, Lynch KE, Brent GA, Kalantar-Zadeh K. Updates on the management of diabetes in dialysis patients. *Semin Dial.* 2014;27(2):135–45.
- Ricks J, Molnar MZ, Kovesdy CP, Shah A, Nissenson AR, Williams M, et al. Glycemic control and cardiovascular mortality in hemodialysis patients with diabetes: a 6-year cohort study. *Diabetes.* 2012;61(3):708–15.
- Abe M, Kalantar-Zadeh K. Hemodialysis Associated Hypoglycemia and Glycemic Disarrays. *Nat Rev Nephrol.* 2015; 11(5):302–12.
- Stolarz-Skrzypek K, Kuznetsova T, Thijs L, Tikhonoff V, Seidlerova J, Richart T, et al. European Project on Genes in Hypertension I. Fatal and nonfatal outcomes, incidence of hypertension, and blood pressure changes in relation to urinary sodium excretion. *J Am Med Assoc.* 2011;305(17):1777–85.
- Kalantar-Zadeh K, Regidor DL, Kovesdy CP, Van Wyck D, Bunnapradist S, Horwich TB, et al. Fluid retention is associated with cardiovascular mortality in patients undergoing long-term hemodialysis. *Circulation.* 2009;119(5):671–9.
- Kalantar-Zadeh K, Kilpatrick RD, Kopple JD, Stringer WW. A matched comparison of serum lipids between hemodialysis patients and nondialysis morbid controls. *Hemodial Int.* 2005;9(3):314–24.
- Kilpatrick RD, McAllister CJ, Kovesdy CP, Derosé SF, Kopple JD, Kalantar-Zadeh K. Association between serum lipids and survival in hemodialysis patients and impact of race. *Clin J Am Soc Nephrol.* 2007;18(1):293–303.
- Noori N, Dukkupati R, Kovesdy CP, Sim JJ, Feroze U, Murali SB, et al. Dietary omega-3 fatty acid, ratio of omega-6 to omega-3 intake, inflammation, and survival in long-term hemodialysis patients. *Am J Kidney Dis.* 2011;58(2):248–56.
- Kalantar-Zadeh K, Stenvinkel P, Bross R, Khawar OS, Rammohan M, Colman S, et al. Kidney insufficiency and nutrient-based modulation of inflammation. *Curr Opin Clin Nutr Metab Care.* 2005;8(4):388–96.
- Kalantar-Zadeh K, Kopple JD. Trace elements and vitamins in maintenance dialysis patients. *Adv Ren Replace Ther.* 2003;10(3):170–82.
- Winchester JF, Rotellar C, Goggins M, Robino D, Rakowski TA, Argy WP. Calcium and phosphate balance in dialysis patients. *Kidney Int Suppl.* 1993; 41:S174–8.
- Miller JE, Kovesdy CP, Norris KC, Mehrotra R, Nissenson AR, Kopple JD, et al. Association of cumulatively low or high serum calcium levels with mortality in long-term hemodialysis patients. *Am J Nephrol.* 2010;32(5):403–13.
- Li J, Molnar MZ, Zaritsky JJ, Sim JJ, Streja E, Kovesdy CP, et al. Correlates of parathyroid hormone concentration in hemodialysis patients. *Nephrol Dial Transplant.* 2013;28(6):1516–25.
- Hoshino J. Renal rehabilitation in CKD patients. *Jpn J Nephrol.* 2020;62:730–5.
- Hoshino J. Renal Rehabilitation: Exercise Intervention and Nutritional Support in Dialysis Patients. *J Nutrients.* 2021;13(5):1444.
- Smart NA, Williams AD, Levinger I, Selig S, Howden E, Coombes JS, et al. Exercise & Sports

- Science Australia (ESSA) position statement on exercise and chronic kidney disease. *J Sci Med Sport*. 2013;16(5):406-11.
29. Ferguson B. ACSM's Guidelines for Exercise Testing and Prescription 9th ed. 2014; J Can Chiropr Assoc. 2014;58:328.
30. Yamagata K, Hoshino J, Sugiyama H, Hanafusa N, Shibagaki Y, Komatsu Y, et al. Clinical practice guideline for renal rehabilitation: Systematic reviews and recommendations of exercise therapies in patients with kidney diseases. *Ren Replace Ther*. 2019;5:28.
31. Avesani CM, Trolonge S, Deleaval P, Baria F, Mafra D, Faxen-Irving G, et al. Physical activity and energy expenditure in haemodialysis patients: An international survey. *Nephrol Dial Transplant*. 2012;27(6):2430-34.